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XXVI.—*Observations on a Systematic Mode of Craniometry.*
By GEORGE BUSK, F.R.S., F.L.S., etc.

IN the following observations, I can claim but little originality, seeing that the system of measurements of the cranium proposed for adoption, or rather, on the present occasion, for discussion, differs but little except in amplification from that propounded by Professor v. Baer, in a paper in the *Mémoires de l'Acad. Imp. des Sciences de St. Petersburg*, 6me ser., t. viii, in which he describes the characters of various Asiatic and other crania, contained in the anthropological collection in that city. To these measurements I shall afterwards refer.

But before entering upon the immediate subject I am desirous of bringing before the Ethnological Society, I would premise a few words respecting the present value of craniometry in the study of ethnology; that is to say, as to the assistance we may thence derive in the distinguishing of the varieties of the human race. For, whatever opinions may be entertained on the subject of unity or plurality of the human species, it cannot for a moment be denied that permanent, and in their extreme forms, well marked *varieties* of men have existed from all historic times, and are found at the present day, on the face of the earth. That these varieties are distinguished by well marked physical and important psychical characters, cannot be denied. Our object, however, on the present occasion, is simply to inquire into the value of a single character selected from the former category, and whether, and how far, this single character can be relied upon, in the absence of others, to enable us to distinguish one variety of mankind from another.

One reason for the selection of the cranium for this purpose, arises from the circumstance that, of all the individual portions of the bony skeleton, none in the first place is so thoroughly characteristic of man; and secondly, because there is none, speaking generally, which presents such well marked diversities in different races of mankind.

In viewing any collection of crania, the most unobservant will be struck with the fact that the specimens, if sufficiently numerous, may be divided into groups marked with distinctive characters. One set of skulls will be found nearly or quite as broad as they are long, whilst in another the length will considerably exceed the breadth. In some the jaw, with the teeth, or the lower part of the face, will be seen to project, so as to approach the elongated muzzle of an ape, whilst in others the perpendicular profile will, from old associations, persuade us that we are looking upon a more perfect or elevated type.

These broad distinctions, and several others, such as a greater or less height, an oval or oblong, a triangular or rounded outline of the cranium when viewed from above, a greater or less width and difference in position of the cheek bones, a uniformly arched or a pyramidal form to the upper part of the skull—all these characters will be obvious enough to the casual observer; and when he is told that these various forms have been found by observation to be peculiar to particular races or to particular regions, and that, so far as investigation has extended, they are as permanent and as unalterable by external conditions as any other characters that can be pointed out, no one will deny that it is an important problem in the natural history of man to determine how far these and other less obvious characters may be so expressed as, in the absence of the objects themselves, to enable others to appreciate them; and so defined as to admit of accurate or approximately accurate comparison *inter se*.

The present attempt is justified, perhaps, by the fact that at the present time, as is said by Professor Wagner, in a recent memoir on this subject, "we possess no exact methods of estimating the morphological relations of the cranium, or of expressing them in clear and definite terms."

This deficiency has not arisen, however, from want of attempts to carry out such a design, but, as it seems to me, from the methods never having been conceived in sufficiently general terms.

The study of the human cranium, in an ethnological sense, is a recent one, and may be said to date from Blumenbach: that eminent physiologist, however, was contented with a survey of the general form of the skull, and appears to have devoted little or no attention to any systematic measurement of its dimensions. Since his time, various modes of measuring the cranium, and of ascertaining its capacity, have been proposed for different purposes. Some very ingenious, but most of them so complicated and inapplicable, except for the special purposes in view of the proposer, that it may truly be said, as asserted by Professor Wagner, that we are as yet without a generally adopted mode of making comparative craniometrical measurements.

Since Blumenbach, the most important researches on the subject of ethnological craniology have been those of Professor Retzius of Stockholm, whose early death science has recently had to deplore, and of the illustrious Professor v. Baer of St. Petersburg, in whose steps I began by saying I was but a humble follower.*

One important benefit was conferred upon craniology by Professor Retzius in the proposal of terms, since almost univer-

* Davis, Van der Hoeven, and others.

sally adopted, by which certain of the more strongly marked of the varieties of crania, I have before adverted to, are commonly designated. It is to him that we owe the terms *brachycephalic* and *dolichocephalic*, with their respective modifications of *orthognathic* and *prognathic*, and under which, in a certain sense, all the forms of human crania may be classified. His great merits in other departments of ethnology it would be out of place here to touch upon.

Useful as these terms have been found, as expressing a certain collection of facts, it cannot be denied that they are wanting in precision. Professor Retzius nowhere, so far as I am aware, gives any terms or figures by which the proportions constituting a dolichocephalic or a brachycephalic cranium can be distinguished, nor any strict criterion which may determine an observer, in a doubtful case, to place a cranium in the one class or the other; and the same may be said of the varying degrees of height of the cranium, of prognathism, zygomatic width, and so on. One object I have had in view in the scheme of measurements now proposed, is that precise numerical values should be employed in place of words, in speaking of the proportions of a cranium; or, at any rate, that any term employed should be associated with some given numerical value.

This idea, or something like it, though I cannot find that he has openly expressed it, appears to have been entertained by Professor v. Baer, who seems to have been the first to express the proportions, or some of the proportions, of a cranium in terms of a common module. It is only recently, upon consulting his memoir above referred to, that I was aware of this fact, and I have been gratified in finding that I was preceded by so eminent a guide in the selection of the length of the cranium as the module in question. It will readily be seen that by the adoption of this plan, though whether the length or any other dimension, the standard of measure may be left for the present undetermined, the comparative length or shortness of a skull may be accurately expressed in figures. As, for instance, assuming the length as the standard, crania as regards their length may be said to have the breadth as $\cdot 6$, $\cdot 7$, $\cdot 8$ or $\cdot 9$ of the length, the two former numbers actually embracing all the crania hitherto classed under the dolichocephalic type, whilst under the two latter will be found included all the so-termed brachycephalic skulls. By reference again to the same module, the degree of prognathism, or of occipital projection, of height, of zygomatic breadth and so on, may also readily be expressed, and placed in columns in a table, so that the comparison of one set of forms with another, and their average values, may be seen at a glance.

Professor v. Baer divides his table of measurements into 13, or, more properly speaking, into 19 columns, thus arranged :

1. The length of the cranium, measured from the glabella to the most prominent point of the occiput, unless that happen to be an inordinately developed spine.

2. Its height, measured from the plane of the foramen magnum to the highest part of the vertex.

3. The width, measured wherever it may be greatest; the position of this part being indicated by the point in a vertical line, drawn from the centre of the auditory foramen to the vertex, notice also being taken whether it be before or behind this line.

4. The width of the frontal bone, at the narrowest, that is to say, at the anterior, and at the widest part.

5. The parietal breadth, measured from one parietal protuberance to the other.

6. The zygomatic breadth.

7. The horizontal circumference of the cranium.

8. The vertical arch, as he terms it, subdivided into three portions; but for what reason he has adopted the peculiar subdivisions he has, I cannot explain.

9. What he terms the *longitudo racheos*, or *longitudo corporum vertebrarum* ex quibus calvarium constitutum est. This means the distance from the anterior border of the foramen magnum to the fronto-nasal suture.

10. The transverse circumference of the calvarium at the junction of the parietal and occipital regions, indicated (*a*) by a line drawn round the occiput on a level with, and, I presume, slanting from the centre of the auditory foramen to the other. (*b*.) The transverse diameter or greatest chord of the occipital arc.

11. The distance from the centre of the auditory foramen to the middle of the glabella, and from the same point in the auditory foramen to the most distant part of the occiput. The comparison of these measures "indicates," he says, "the evolution of the occiput."*

* In their admirable work, the *Crania Britannica*, Messrs. Davis and Thurman employ the following measurements: 1. Horizontal circumference; 2. Longitudinal diameter; 3. Frontal region—(*a*) length, (*b*) breadth, (*c*) height; 4. Parietal region—(*a*) length, (*b*) breadth, (*c*) height; 5. Occipital region—(*a*) length, (*b*) breadth, (*c*) height; 6. Intermastoid arch; 7. Internal capacity; 8. Face—(*a*) length, (*b*) breadth. Most of the above will be found included in my scheme; the only omission of importance in that, perhaps, being the internal capacity; but this, I think, is hardly worth the trouble of ascertaining. The chief point, as it seems to me, being to determine the relative dimensions of the three great cranial regions. The gross capacity varies, of course, according to the size of skull, which may differ very widely, even in well marked crania, of one and the

I will now proceed to describe the measures I have been led to adopt, and it will be seen that my system is in a great degree borrowed from, and coincides with, that of Professor v. Baer, though the principles upon which they are respectively based are not, perhaps, exactly identical. What I have had chiefly in view was to continue to place in as few columns as possible such measurements as might be readily made, for the most part, even in imperfect skulls, and what may yet suffice to shew,

1. The proportions of the entire *cranium*, as regards *length*, *breadth*, and *height*.

2. The comparative capacity, or size rather, of the *frontal*, *parietal*, and *occipital* regions, corresponding to the main divisions of the brain.

3. The degree of pro-or orthognathism, and of the occipital projection, and, inferentially, to indicate the position of the *foramen magnum*; and

4. By the comparison of two measures, that is to say, of the length of the nasal radius (mihi), (*cranial vertebral axis*, v. Baer), with that of the maxillary radius, to arrive at some notion of the facial angle, which, without the aid of a complicated and expensive apparatus, such as the ingenious instrument of M. Jacquart, it is difficult, if not, in some cases, impossible, to estimate with any approach to accuracy.

The measurements I propose may be arranged in a tabular form in 23 columns, beyond which several others may be left for the insertion of the *proportions* of the various dimensions to each other, calculated in terms of a common standard or module, for which, as before said, the *length* of the cranium may be conveniently taken.

Besides these, in some printed tables drawn up by myself and the late Professor Quekett, five more columns are added, for the facial angle and the various proportions of the lower jaw, upon which Professor Quekett placed considerable value.

The first 14 columns contain all the measures which require a single instrument fitted to measure the distances between two points in a straight line. Various contrivances, of course, may be used for this purpose, such as callipers, compasses, etc.; but in practice I have found that the proceeding is much facilitated

same race, depending, in great measure, upon the stature, or size, of the individual. Thus, the Negroes of the Cape de Verd Islands, who are generally very tall and strong men, and several races of continental Negroes of large size, have very capacious crania, in which, however, the Ethiopian character is as well expressed as in the smaller ones.

Many other lists of measures might be given; but I have stated enough to show that, at present, no uniform system has been adopted by Ethnologists in general.

by the employment of a simple instrument constructed on the principle of a common shoemaker's gauge, and consisting of a straight stem about twelve inches long, having an arm jointed to it at one end, which can be opened out to an exact right angle, and a second arm which can be slid up and down the stem, also at a right angle. These arms should be about six inches long, and the whole should be made sufficiently strong and rigid that

parallelism of the arms may be perfectly maintained under moderate pressure upon an object placed between them towards their free ends. The best material, as being the lightest, is boxwood; and I have found that a width of about one inch, and the thickness of an ordinary foot rule, are quite sufficient. The stem should be graduated in inches and tenths on one side, and in centimeters and millimeters on the other, so that either the English or the French measure may be used *ad libitum*. The graduation, of course, should commence from the fixed arm. Each arm should also be graduated in the same manner, the graduation starting from the stem. With this simple craniometer all the measurements in the first columns may be very quickly taken. But it will be convenient to say a few words respecting what I have termed the *radial* measures. In making these measures, as for other purposes afterwards to be adverted to, I, following v. Baer, take the centre of the *external auditory foramen* as the starting point. In order to ensure accuracy in the length of the radial line, it is, of course, necessary that it should be measured in a direction parallel to the vertical longitudinal plane of the skull, and this I have found can only be done with facility and correctness in one of the following ways:—It may be done either by fixing a small conical cork in each auditory foramen, supporting a needle in its centre, which will project about an inch from the side of the skull. If the craniometer with both arms at a right angle to the stem be then placed with the stem upon the point to which the radial line is to be measured, and the arms are brought down on each side over the auditory opening, the needles on either side ought to point to the same degree of the scale on each arm if the arms are parallel to the mesial vertical plane, and the degree pointed at will be the radius sought; or 2, a small sliding piece may be made to fit on each arm, having a conical plug, to be inserted into each auditory opening, which will answer the same purpose as the cork and needle, with perhaps greater certainty.

The measurements in the next nine columns are all made with the measuring tape. The manner of taking them is too obvious to require any special remark.

But another part of the subject, in my opinion even of

greater importance than the taking of measurements, is a method of making such *delineations* of the cranium as may be relied upon for its accurate comparison with others. Of the numerous, and many of them admirable, representations of human crania hitherto published, few or none that I have seen suffice to show the actual forms and dimensions in such a way that direct comparisons can be made between different figures in these particulars.

The object, as it seems to me, to be held in view in preparing figures of crania for ethnological or similar scientific purposes, is, 1, that the cranium should invariably be represented in a certain defined position; 2, that it should be drawn either of the natural size, or reduced to a given proportion, alike in all cases; 3, that so many figures should be given as, without any perspective, may afford a sufficient idea of the outline of a section of the cranium in the three dimensions of *length*, *breadth*, and *height*, together with a view of the *face* as seen in front, and of the *base* regarded as in a horizontal plane. Five figures of a skull, consequently, are indispensably requisite to afford an adequate idea of its conformation and dimensions, so far as that can be derived from any mere delineation.

The above objects I have endeavoured to carry out in the following manner:—

1. *Position of the Cranium.* Stretch the measuring tape from the centre of the left auditory opening to the junction of the sagittal and coronal sutures, and along it draw a pencil line. This line, which, so far as I know, was first suggested by l'Abbé Frère, may be assumed to represent the *vertical line*, and it serves as the invariable standard of position.

2. A line at right angles with the vertical, and crossing it at the centre of the auditory foramen, I regard as the *horizontal* or *base line* of the cranium; and it will be found to coincide pretty nearly with the base line of most writers, and to be nearly coincident in most cases with the floor of the nostrils. Any remarkable deviation in this respect will be worthy of remark.

With respect to the size of which crania should be represented, convenience alone would suggest that one below the natural should be adopted; and, for all the purposes contemplated in this paper, it would appear that they will be answered by figures half the size of nature as well as by larger ones, which, though occupying four times the space, are not a whit more useful, nor, in fact, more natural, when we consider the usual distance at which a skull and a drawing of a skull are respectively viewed. I therefore propose that all figures of crania should be drawn to a scale exactly one-half

the size of nature.* The cranium then being placed by any convenient contrivance with the vertical line perpendicular, and with its left side towards the observer, the camera lucida is placed at the proper distance, and so and at such a height that the centre of the prism is opposite the vertical line, and on a level with a spot midway between the base of the skull and the vertex. The side view having been thus taken, and found by actual measurement to agree with the truth, the skull is turned round in the same horizontal plane and level, so that the back is presented to view, and at such a distance that the breadth in the figure is found by measurement to agree with the actual greatest breadth; the figure when drawn will therefore represent the transverse vertical section of the skull at its widest part, as the former shows its longitudinal section. Without otherwise altering the position of the cranium upon its support, it is then turned round so as to present the face to the observer, and placed at such a distance from the camera that the measured distance between the external orbital processes of the frontal bone agrees with the figure thrown on the paper by the camera. The drawing, in this position, affords a view of the shape and comparative height of the forehead, the form of the orbits, and of the nasal opening, etc. The skull is now to be placed and supported on the occiput, the vertical line being made horizontal, and the centre of the prism made to coincide with the level of the vertical point—that is to say, the junction of the sagittal and coronal sutures. In this position, figures are taken, 1, of the vertical view, the outline corresponding by measure with the greatest breadth; and 2, of the base (without the lower jaw), which latter view is taken at such a distance that the space between the points of the mastoid processes is found by measure to agree with the figure projected on the paper. This aspect will present the shape and width of the maxillary arch, the position and form of the foramen magnum, etc.

I cannot conclude without apologizing for the length of time I have occupied your attention upon so dry a subject; but have thought that, to make it of any interest, or the discussion of any utility, it was necessary to enter into minute details which could not fail to be tedious in the recital, though requisite for the full understanding of what I was desirous of bringing before the Society.

* It is my intention shortly to bring out the first decade of "*Crania Typica*," with a view of showing the way in which this plan might be carried out.